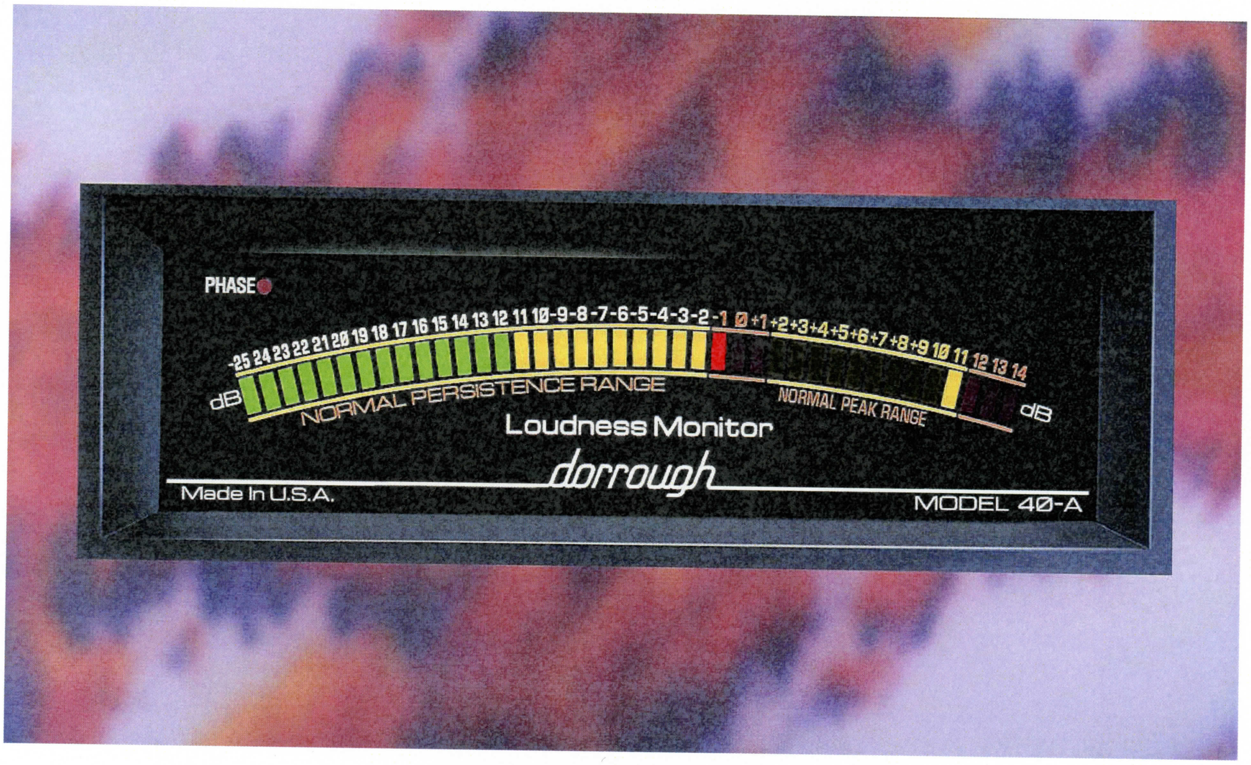
Analog and Digital Audio Loudness Meters


PHASE
-25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 10 11 12 13 14
dB
NORMAL PERSISTENCE RANGE
NORMAL PEAK RANGE
dB
Loudness Monitor
dorrough
Made In U.S.A.
MODEL 40-A

Technical Manual

Covering all Current Models

December 16, 2002

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Analog and Digital Audio Loudness Meters

Technical Manual

Dorrough Electronics is proud and grateful to be a 2000 Academy of Television Arts and Sciences Emmy winner for Outstanding Achievement in Engineering Development for the Dorrough Loudness Meter.

July, 2003

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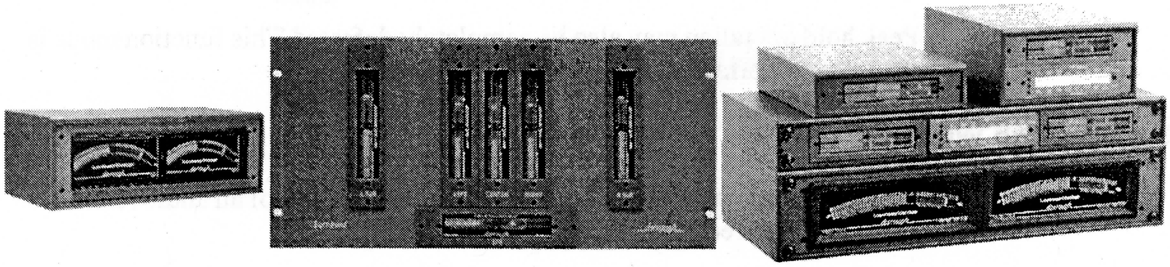
Overview 1



This Dorrough series are third-generation Loudness Monitors providing the same basic display ballistics as the original classic Model 40 but with added audio monitoring functions.

Using advanced digital semiconductor technology, this generation of meters offers an unprecedented level of monitoring precision and functionality for professional audio production and quality assurance environments.

Two Channel Inputs

On all models (except for the 280/380 series as space did not permit), two audio input channels provide the ability to monitor stereo phase. A phase error Alarm indicator LED in the upper left corner of a stereo pair indicates a phase error warning while in normal stereo operation. A contact closure on the 8-pin mini DIN provides a phase error warning to a remote location.

The optional RW-100 Remote Control accesses this feature and displays it as a full scale correlator on the face of the meter along with the LED warning light on the meter's face while in normal stereo operation.

Access to the correlator display can also be done through the Peak Hold Switch. With DIP Switch #5 set to "ON" the correlator function appears on the three position Peak Hold switch (See Table 1).

Peak Hold Functions

All models provide two peak hold functions: 3-second auto reset and hold until reset. These functions are selected through a three-position toggle switch or the optional remote control unit. Peaks in real-time are always displayed.

Peak hold for 3-seconds auto reset is enabled by the toggle switch, or through the optional remote control. In this mode, the highest peak is held for 3-seconds before being reset.

Hold until reset retains the highest peak that has occurred for an indefinite period while constantly resampling. This function is particularly useful for unattended operation where the engineer wishes to record the highest audio peak occurring during a mastering operation, or at a remote transmitter site, etc. The peak is cleared by switching the toggle switch to normal, then back to indefinite peak hold.

Peak hold operation may also be completely defeated.This function mode is the meter's normal operating mode.

The Dorrough Window

This is an automatic function for precision verification of an audio reference tone. This is a recommended practice of SMPTE.

The meter automatically enters an expanded display mode when the reference tone (any frequency) is detected. A blinking "target" LED near the center of the scale shows the reference point. The operator then simply adjusts the reference tone level until the bargraph above or below the reference LED disappears leaving only the blinking LED. At this point, the reference level is accurate to within 0.1dB.

The meter automatically resumes display of normal program audio once the reference tone is switched off.

This function is controlled on the Mode DIP switch, position #2.

Phase Display

This series of meters can display true phase correlation between the left/ right audio signal pair.

The display feature is activated through the meter's Mode DIP switch position #5 in conjunction with the three-position toggle switch (see Table 1 on page 13). Depending on the position of DIP Switch #5, access to the functions of Peak Hold and Phase Correlation display are enabled through the toggle switch.

Note: *Permanent Hold is on the OFF side and Phase Correlation display is on the ON side of the Mode DIP switch position #5.*

When the Mode DIP switch position #4 is ON, the LED in the upper left corner of the meter face will alarm (light) upon detection of a phase error.

Nominal in-phase stereo signals usually place the lit indicator on the right-hand side of the display.

In the event that input signal levels fall below 30 dB down from full scale, the phase indicator slews to the center position, indicating that the level is below the reliable reading threshold.

Alarm Functions

These meters feature an alarm closure which can be used to detect input signal parameter violations. The alarm closure is available on a DIN connector on the meter's rear panel (an open drain FET). The circuit closure can be wired to a beeper, local alarm, or external computer input to signal violations.

The following conditions activate the alarm:

1. The audio levels are insufficient to cause a display for a two-minute period.
2. Program level is full scale or greater for a period of one or more sample periods.
3. Stereo phase error.
4. The AES/EBU bitstream is corrupted or missing (digital meters only)

Refer to the Alarms section at the end of Chapter 3 for details.

Installation

2

Installation of the meter is straightforward and easy. When multiple meters are installed in a console the use of a common power supply is recommended. Installation procedures are provided in the following pages.

Mounting

Models 10/12/20/240/280/340

The models 10, 12, 20, 240, 340, and 280 analog and digital can be horizontally mounted in a console or in rack adapters available from Dorrough. If you wish to install a meter in a console or other equipment, the following panel space is required:

Model	Panel Dimensions (in inches)
10	5.0W X 2.5H X 3.0D
12	8.75W X 3.125H X 3.0D
20	8.5W X 1.75H X 3.0D
240	5.0W X 1.5H X 5.0D
280	1.5W X 5.0H X 5.0D
340	1.5W X 5.0H X 5.0D

See our website (www.dorrough.com) for custom mounting options, or contact us for alternate mounting options.

Model 40

The model 40 can be placed on a desktop or mounted in an optional single or dual meter rack adapter. See our website (www.dorrough.com) for custom mounting options.

Model 400

The model 400 is a large stage production model measuring 23.0W X 8.0H X 4.75D (inches). An installation instruction sheet is provided with this meter.

Analog Meters: Electrical

All electrical inputs for the analog meter line are configured exactly the same electrically, but differ physically.

Two styles of connectors are used for the audio inputs based on available space. The models 10 and 20 use a Phoenix/Euroblock connector. Refer to the Analog Meter Rear Panel Connections Figures 5 and 6 for connector pinout details.

The models 12, 40, 240, 280, and 340 use two XLRs for right and left audio inputs. Note that loop-through is not supported on these meters.

Note: *If only a left channel and a right channel of audio is desired, input connection to the LEFT only input on each meter is recommend.*

When installing meters between two pieces of equipment a "T" or "Y" configuration is required. Grounding is not required as the meter are very low impedance.

The 8-pin mini DIN connector provides access to meter functions for any one of the following:

1. The RW-100 Remote Control,
2. a remote alarm device,
3. a Peak Hold switch (Model 12 analog and all digital meters).

Input Signal Connections

All Dorrough analog meters are designed to accept balanced or unbalanced lines, or balanced lines through the XLR input connectors. Inputs are bridging, with a nominal input impedance of 20K ohms differential or 10K ohms single-ended. Single ended (unbalanced) sources may be connected to pins 1 and 2, pins 1 and 3, or pins 2 and 3.

If termination resistors are desired, they must be connected externally to the meter. Termination is not normally used except on long cable runs.

Connections to the XLR connectors are industry standard:

1- Shield/ground
2- High or non-inverting input
3- Low or inverting input

Note: *If referencing source to ground, use XLR pin 1 as ground. DO NOT use the meter power supply ground.*

Stereo Phase Monitoring with 2 Meters

To take advantage of the stereo phase alarm and phase correlation display capability of these meters, a non-standard hookup convention is required.

Illustrated in Figures 1 and 2 are wiring diagrams for using a pair of single channel meters for stereo monitoring in both balanced and unbalanced circuits (see also the following rear panel photos for connector locations).

Note that the same wiring also applies to the model 10 and 20 meters except that connections to the meter are made through Phoenix/Euroblock connectors.

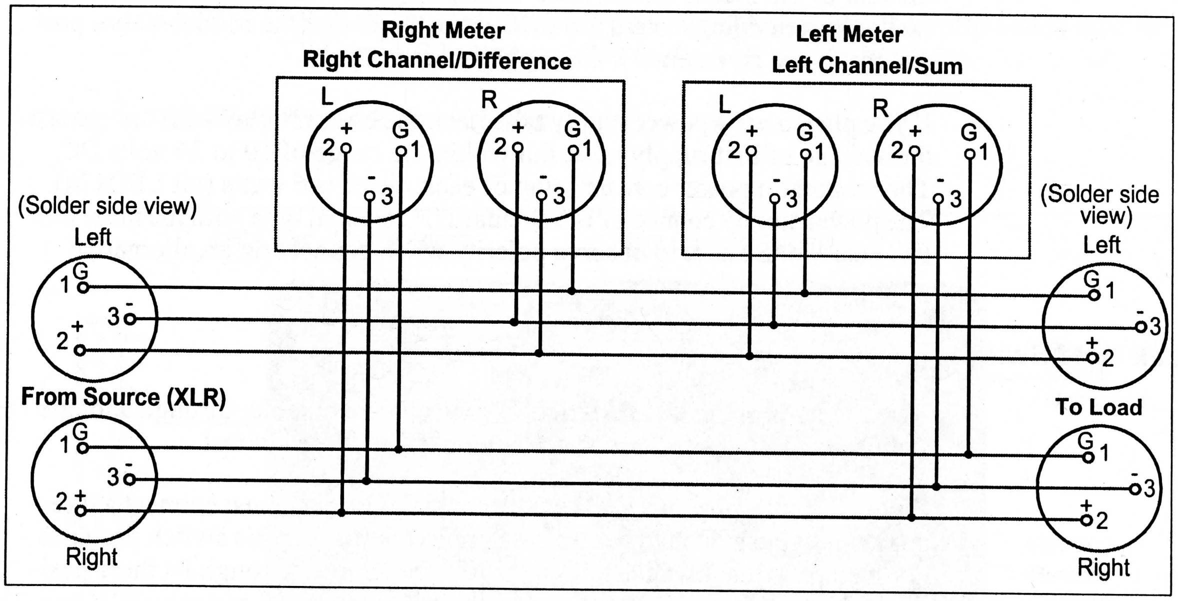

Right Meter
Right Channel/Difference
Left Meter
Left Channel/Sum
L
R
+
G
2
1
-
3
(Solder side view)
Left
From Source (XLR)
Right
(Solder side view)
Left
To Load
Right

Figure 1, Stereo Monitoring Wiring for Balanced Lines

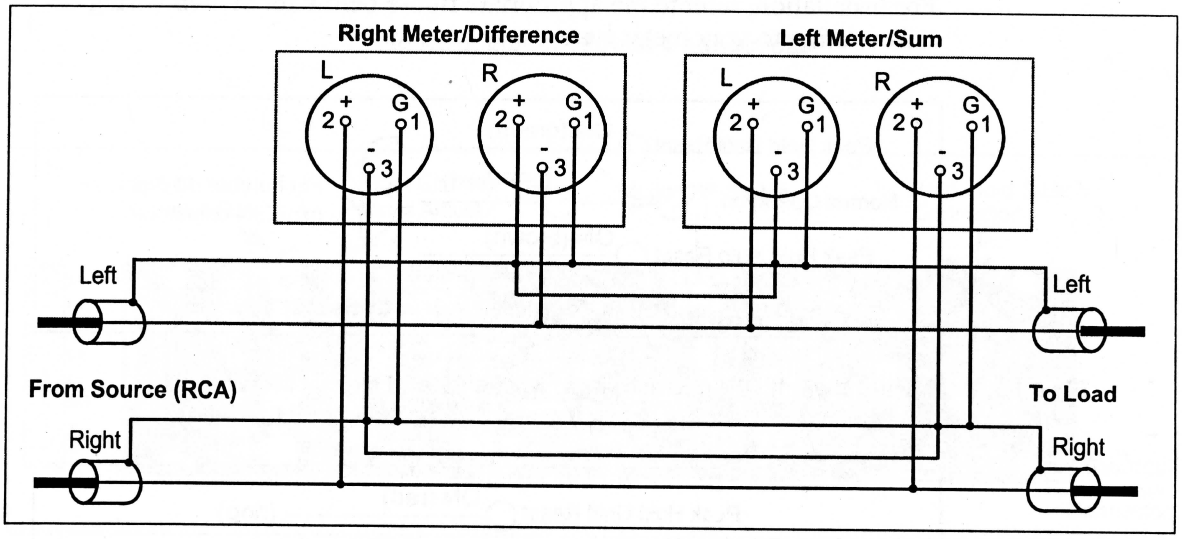

Right Meter/Difference
Left Meter/Sum
L
R
+
G
2
1
-
3
Left
From Source (RCA)
Right
Left
To Load
Right

Figure 2, Stereo Monitoring Wiring for Unbalanced Lines

Power Supply Connections

The 40 series is the only meter with an internal power supply: all others are supplied with a power pack which plugs into the mating power connector at the rear of the meter. The Models 10 and 20 have mini-Euro connectors while the remaining meters have DC jacks. Note that the Model 40 has provisions to use an external DC supply if necessary.

If you plan to use a power supply other than the one provided with the meter, the voltage of that supply must fall within the range of 10 to 24 volts DC. The maximum power consumption of each meter is 6 watts (all LEDs lit). The power supply connector is a standard DC coaxial type with the inner pin DC positive. Be sure to observe polarity when connecting an alternative power source to the meter.

Peak Hold Switch

Two methods of Peak Hold function control are available: through a toggle switch, or through the keypad on the optional remote control.

If you do not use the optional remote control unit, you must connect a three position toggle switch to control peak hold functions. This switch provides normal operation, hold until reset, or peak hold auto, through its three positions. For the Model 12 meter, the switch plugs into the 8-pin mini DIN connector. For all other analog meters, the Peak Hold toggle switch plugs into a mini-phone jack at the rear of the meter.

For installation, refer to the appropriate figure below for switch wiring details relating to your meter type.

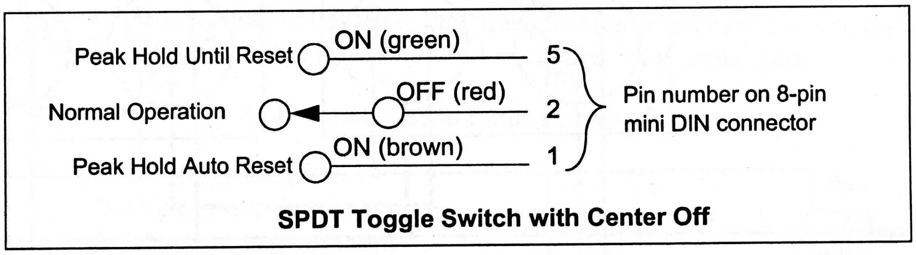

Peak Hold Until Reset
ON (green)
5
Normal Operation
OFF (red)
2
Pin number on 8-pin mini DIN connector
Peak Hold Auto Reset
ON (brown)
1
SPDT Toggle Switch with Center Off

Figure 3, Peak Hold Switch DIN Connections: Model 12 and Digital Meters Only

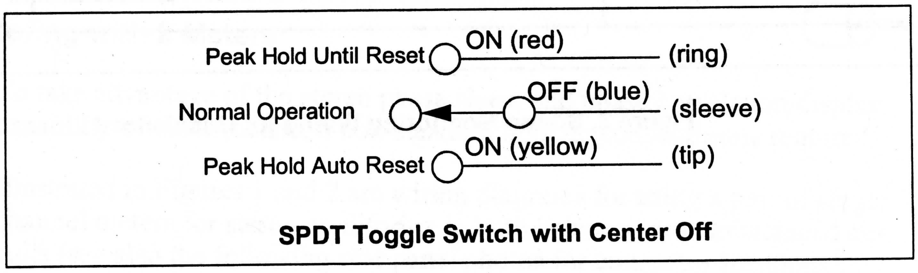

Peak Hold Until Reset
ON (red)
(ring)
Normal Operation
OFF (blue)
(sleeve)
Peak Hold Auto Reset
ON (yellow)
(tip)
SPDT Toggle Switch with Center Off

Figure 4, Peak Hold Switch Connection for All Models Except 12 (Mini Phone Plug)

Note: *The Mini-phone plug is a Digi-Key Part number CP-3502-ND, while the toggle switch is a Digi-Key EG-2376-ND.*

Level Adjustment Controls

All analog meters have reference level adjustment potentiometers labelled VR1 and VR2 corresponding to the Left and Right inputs.

Analog Meter Rear Panel Connections

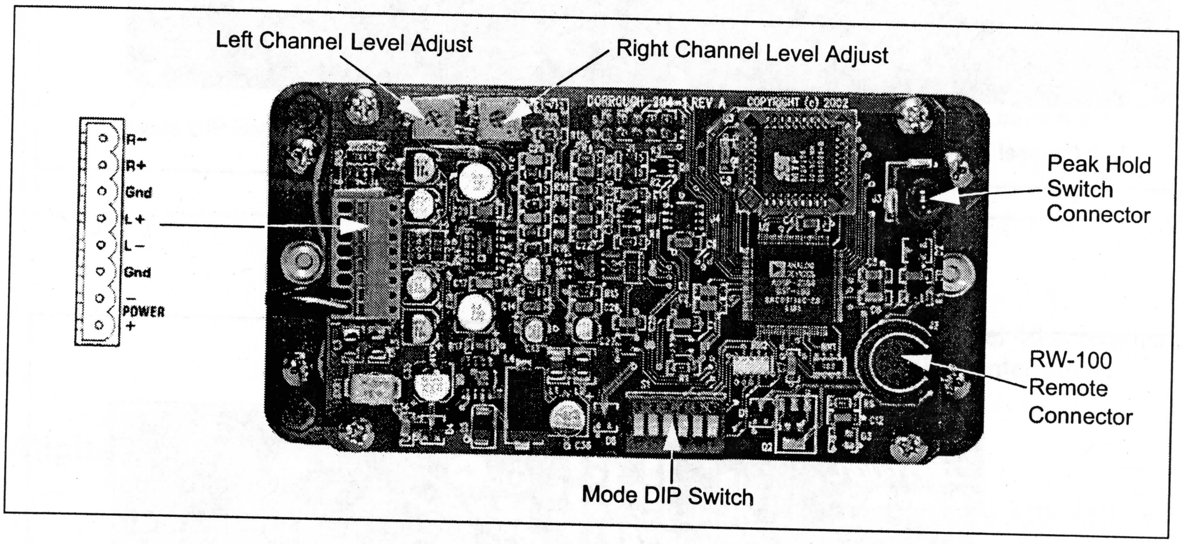

Left Channel Level Adjust
Right Channel Level Adjust
R-
R+
Gnd
L+
L-
Gnd
- POWER +
Peak Hold Switch Connector
RW-100 Remote Connector
Mode DIP Switch

Figure 5, Model 10 Rear Connections

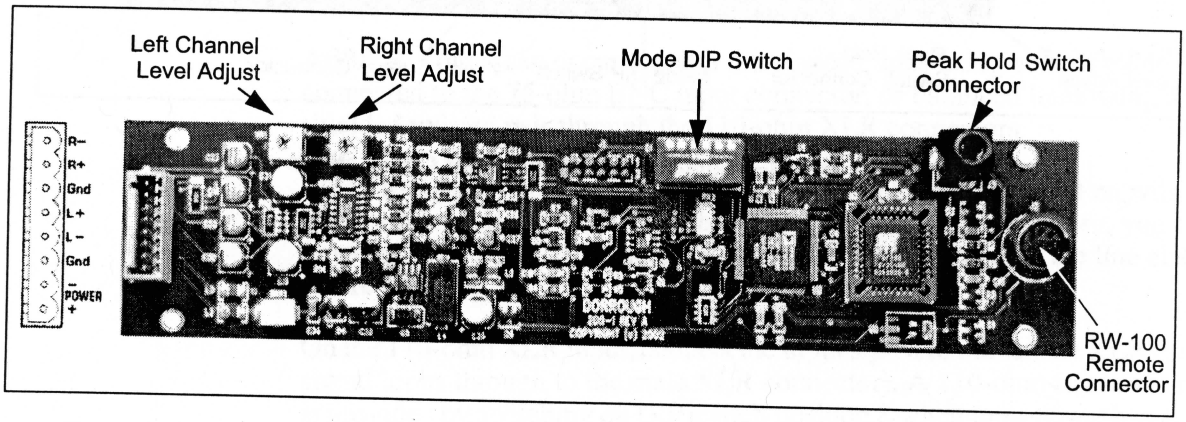

Left Channel Level Adjust
Right Channel Level Adjust
Mode DIP Switch
Peak Hold Switch Connector
R-
R+
Gnd
L+
L-
Gnd
- POWER +
RW-100 Remote Connector

Figure 6, Model 20 Rear Connections

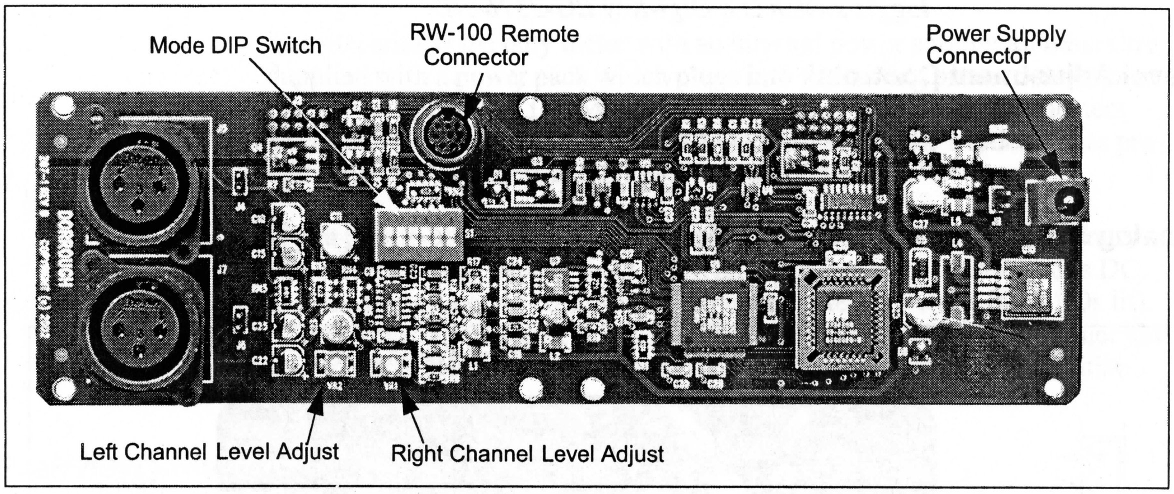

Mode DIP Switch
RW-100 Remote Connector
Power Supply Connector
Left Channel Level Adjust
Right Channel Level Adjust

Figure 7, Model 12 Rear Connections

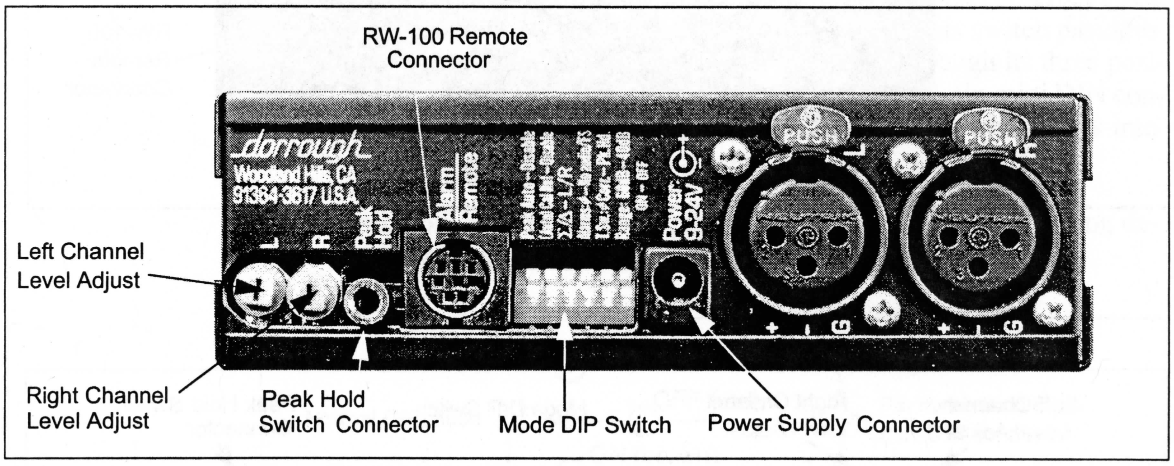

RW-100 Remote Connector
Left Channel Level Adjust
Right Channel Level Adjust
Peak Hold Switch Connector
Mode DIP Switch
Power Supply Connector
dorrough
Woodland Hills, CA
91364-3617 U.S.A.
L
R
Peak Hold
Alarm Remote
Power: 9-24V
PUSH
L
R

Figure 8, Models 240/340 and 280/380 Rear Connections

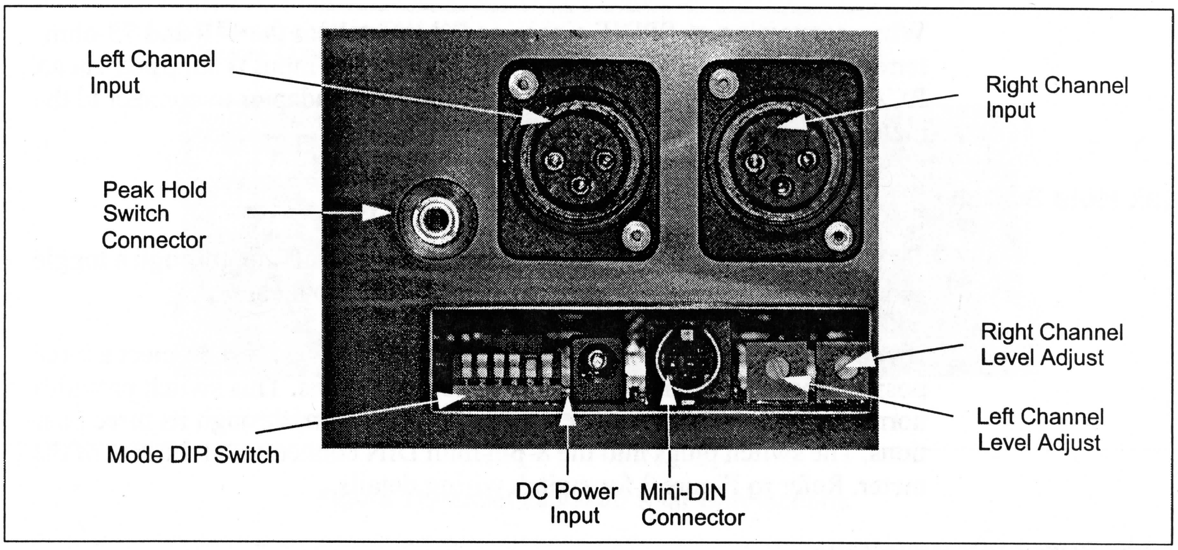

Left Channel Input
Peak Hold Switch Connector
Mode DIP Switch
DC Power Input
Mini-DIN Connector
Right Channel Input
Right Channel Level Adjust
Left Channel Level Adjust

Figure 9, Model 40 Rear Connections

Note that if use of an external power supply with the Model 40 is required, this supply must provide 9-24VDC at 500mA, with the center pin +.

Digital Meters: Electrical

The Model 12-AES and 280/380 Digital meters can accept AES/EBU or SPDIF signals. Because the digital signal arrives at the meter in one wire, only one input is required. The second XLR or second BNC connector can be used as a loop-through.

AES/EBU Input

AES/EBU input can occur through unbalanced lines using coaxial cable connected to the 75-ohm BNC input connector, or balanced lines using a shielded twisted pair through the 110-ohm XLR connectors.

When using the 75-ohm BNC input, termination can be switched on with DIP switch position 7. If a loop-through configuration is necessary, you must supply a BNC “T” externally to the meter and terminate the line elsewhere (#7 OFF).

On the 110-ohm XLR input, connect the input signal to the female XLR (the signal loops through to the male XLR connector). A 110-ohm termination is provided by switching on DIP switch position 8 when loop-through is not used (#8 ON).

Note: *XLR input, non-loop through: 110-ohm termination ON (DIP switch #8)*
BNC input, non-loop through: 75-ohm termination ON (DIP switch #7)

SPDIF Input

When connecting an SPDIF single-ended input, both the 110 and 75-ohm terminations must be "OFF". Normally the SPDIF input is supplied via an RCA connector: use a female-RCA to male-BNC adapter to connect to the meters BNC input.

Peak Hold Switch

Two methods of Peak Hold function control are available: through a toggle switch, or through the keypad on the optional remote control.

If you do not use the optional remote control unit, you must connect a three position toggle switch to control peak hold functions. This switch provides normal operation, hold until reset, or peak hold auto, through its three positions. The switch plugs into the 8-pin mini DIN connector on the rear of the meter. Refer to Figure 3 for switch wiring details.

Power Supply Connections

All digital meters are supplied with a power pack which plugs into the mating power connector at the rear of the meter.

If you plan to use a power supply other than the one provided with the meter, the voltage of that supply must fall within the range of 10 to 24 volts DC. The maximum power consumption of each meter is 6 watts (all LEDs lit). The power supply connector is a standard DC coaxial type with the inner pin DC positive. Be sure to observe polarity when connecting an alternative power source to the meter.

Digital Meter Rear Panel Connections

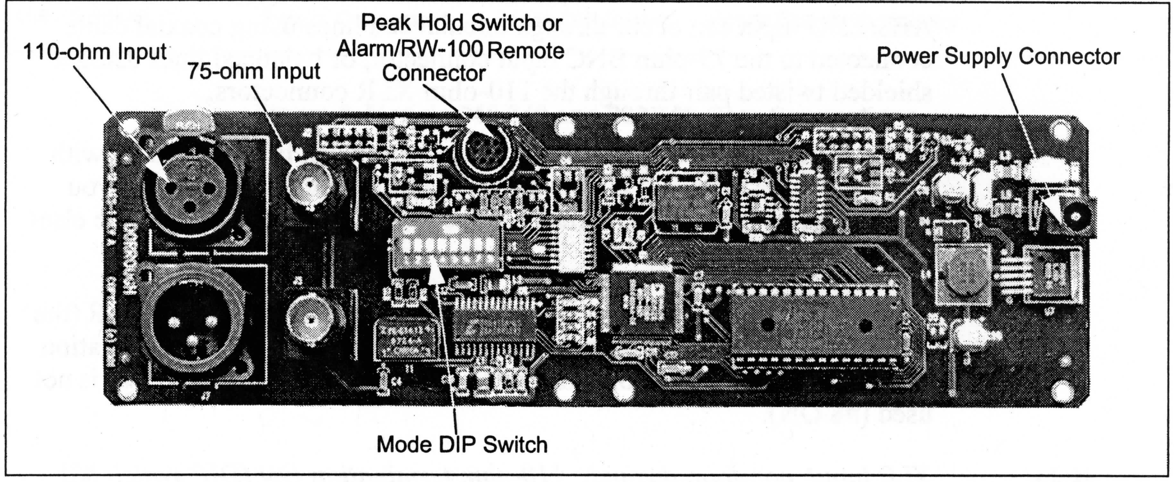


Figure 10, Model 12 AES Rear Connections

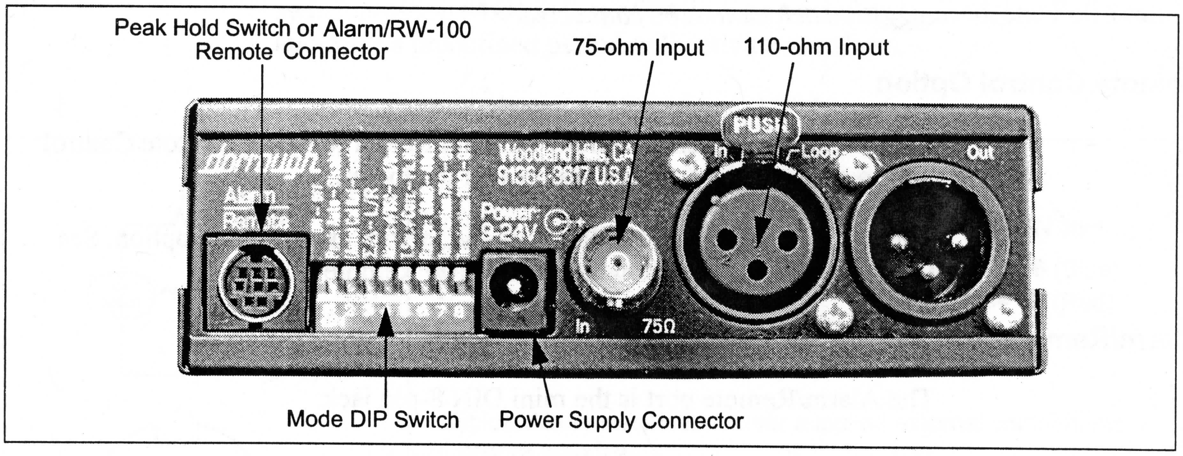

Peak Hold Switch or Alarm/RW-100 Remote Connector
75-ohm Input
110-ohm Input
Mode DIP Switch
Power Supply Connector
dorrough
Alarm Remote
Woodland Hills, CA 91364-3617 U.S.A.
Power 9-24V
PUSH
In
Loop
Out
In 75Ω

Figure 11, Model 280/380D Rear Connections

DIP Switch Configuration (All Meters)

The following describes the functions of all DIP switch positions. Note that the digital meters have two additional switch positions. Some functions may be duplicated by the external peak function toggle switch or the RW-100 remote control if either is plugged in.

Table 1, DIP Switch Functions

Position	On Function	OFF Function
1 Peak Auto	3-Second Peak Hold	Disable
2 Ref Scale	Expansion mode ON (enabled)	Exp Mode (Dorrough Window) OFF
3 Mode	Σ (Δ)*	LEFT(RIGHT)*
4 Alarms	Alarm on stereo out-of-phase error	Alarm on Audio Loss (2 min)
5 Peak/Phase	1. Peak auto displays 2. Normal 3. ϕ correlation displays *(disregard right channel)*	1. Peak auto displays 2. Normal 3. Peak hold displays
6 Range	60 dB display scale (factory use only)	40 dB display scale (factory use only)
7** Termination	75-ohm termination for the unbalanced BNC input ON	75-ohm termination OFF
8** Termination	110-ohm termination for the unbalanced BNC input ON	110-ohm termination OFF

* Per Wiring Diagram
** Only on Digital Meters

Note: *If the RW-100 Remote Control is being used and enabled, the Peak function toggle switch cannot be connected.*

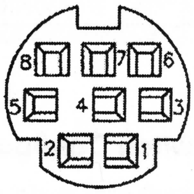
Remote Control Option

All meters may be used with the optional Model RW-100 Remote Control unit to activate all available features on the meter.

The remote control is available from the factory as a separate option. See Chapter 4 for a description of the RW-100 Remote Control.

Alarm/Remote Port Connector Pin Assignments

The Alarm/Remote port is the mini DIN 8-pin jack.



If the use of a custom control panel is desired or access to the alarm output pins is required, connections should be made according to the pin assignments in the table below.

Toggle switches may be used to control meter functions with contact closure between the desired function and ground to activate the function. Peak function modes require an SPDT toggle switch with a center-off position.

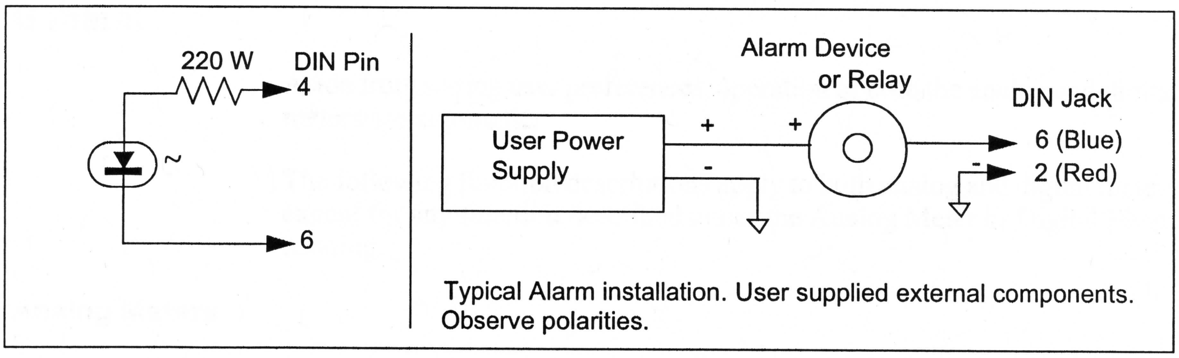
Table 2, Alarm/Remote Port Pin Assignments

Pin	Function
1	Peak Hold Auto (Brown)
2	Ground (Red)
3	No connection (Orange)
4	User +5V out. Do not exceed 100 mA on this pin. (Yellow)
5	Peak Hold Indefinitely (Green)
6	Alarm closure (N channel FET, 30 VDC, 0.5A max). (Blue)
7	No connection (Purple)
8	No connection (Black)

Alarm Indication Connection

In combination with DIP switch position #4 and Pin #6 on the DIN port, access to the alarm modes of phase, loss of audio for a predefined period of time, and Full Scale audio can be wired to an external source.

With DIP switch position #4 ON, a phase error activates the alarm. With switch position #4 OFF, loss of audio for a predefined period, and Full Scale audio for a predefined period will activate the alarm.



Typical Alarm installation. User supplied external components. Observe polarities.

Figure 12, Meter Alarm Connection

Initial Setup

Analog Meters

To verify operation, apply a tone to the meter's input. All Dorrough analog meters are factory set to +4 dB. If you are not +4 referenced to "0", use the Left and Right level controls at the rear of the meter (see Figures 3 and 4 on page 6) to set your desired reference level. Assuming the Dorrough Window mode on DIP switch #2 is ON (enabled), the meter should automatically enter the Dorrough Window Expanded Mode and indicate precisely the level of the reference tone.

If you do not see an indication on the meter, perform the following:

- recheck your connections on the input connector
- ensure the connector is properly seated into the meter's mating connector
- verify DC power is present
- verify a tone is present and within the range of the meter's scale.

Digital Meters

Because the signal and monitoring electronics are entirely digital, no calibration (other than reference level verification) or adjustments are necessary. To verify operation, apply a tone (in the digital format) to the meter's input. Assuming the Dorrough Window mode on Mode DIP switch #2 is ON (enabled), the meter automatically enters the Dorrough Window Expanded Mode and indicates precisely the level of the reference tone.

If you do not see an indication on the meter, perform the following:

- recheck your connections on the input connector
- ensure the connector is properly seated into the meter's mating connector

- verify DC power is present
- verify a digitally encoded tone is present and within the range of the meter's scale.

Operation 3

General

Aside from setting user preferences, operation of both the analog and digital meters are automatic.

The following function descriptions apply to both analog and digital meters except for any function described under the Analog Meter or Digital Meter heading.

Analog Meters

If the input signal is nonexistent, the meter blanks the display and activates the alarm closure for a minimum of 1 second. See the Alarms section at the end of this chapter for a complete description of the alarm feature.

Digital Meters

Because the AES/EBU standard requires format information to be embedded within the audio data frame, the meters software automatically matches its configuration to the format detected.

Any consumer or professional format is automatically detected. This includes audio words of 16 to 24 bits in length and sampling rates of 32, 44.1, 48, and 96 kbs.

If the AES/EBU bitstream to the meter is corrupted, contains errors, or nonexistent, the meter blanks the display and activates the alarm closure for a minimum of 1 second. See the Alarms section at the end of this chapter for a complete description of the alarm feature.

Note: *Digital full scale is standardized as +20dB above +4dBm (+4dBm is the normal program operating level for 600-ohm analog audio lines).*

Digital Full Scale and Overs

A digital "over" is defined as one or more successive digital full scale samples. A full scale sample is defined as an audio word with all its bits set to one after converting the two's complement word to a positive value (audio word = 16 to 24 bits minus the sign bit).

When the meter detects 3 or more full scale samples, it changes the most significant LED from green to red. This indicator is lit only for the duration of the over unless Peak Auto or Peak Hold is enabled.

Digital full scale overs are counted and displayed by the meter with a maximum count of 40 overs. The counter display is accessible through the RW-100 remote control.

When enabled (via the RW-100 remote), a single LED on each meter channel is lit indicating the number of digital overs that have occurred on that channel since the last reset. The number of over events counted correlates with the scale on the front of the meter. If the LED corresponding to the 5dB down scale indicator is lit, 5 overs have occurred in that channel. The overs count begins at the top of the scale (0dB) and counts down. If the least significant LED indicator is lit, 40 or more overs have occurred.

Resetting is accomplished by pressing the Overs Count Reset button on RW-100 remote control.

Peak Display Functions

Two types of peak hold functions are available: 3-second peak hold and peak hold until reset. These functions are selected through a three-position toggle switch, or through the keyboard on the optional remote control unit.

By default, average and instantaneous peak are always displayed, however, the maximum peak can be turned on or off and has two modes:

Auto Peak Hold

Normal operation (peak hold functions disabled) is provided at the center position of the toggle switch as described in the Installation Section of this manual (see Figures 3 and 4).

Enable Auto Peak Hold by moving the toggle switch to Peak Hold Auto, or if the RW-100 remote control is present, pressing the Peak Auto button. In this mode, the highest peak is held for a period of three seconds before automatically resetting.

Auto Peak can also be enabled by DIP switch position 1.

Peak Hold Until Reset

Peak hold until reset retains the highest peak that has occurred for an indefinite period while constantly resampling. The peak is cleared by switching the toggle switch to center, then back to the Permanent Peak Hold position. If the option RW-100 remote control is present, press the Peak Hold key.

This function is particularly useful for unattended operation where, for example, an engineer wishes to record the highest audio peak occurring at a mastering plant, remote transmitter site, etc.

Meter Mode- Left/Right or Sum/Difference

The meter is capable of displaying the sum and difference of the two channel stereo source to which it is connected. Sum/Difference display is enabled by setting the rear panel DIP switch position 3 on, or if the RW-100 remote control is present, by pressing the S/D button. On the meter scale, the left column (or upper row) indicates the signal sum and the right column (or lower row) indicates the signal difference.

The Dorrough Window

The Dorrough Window is an automatic mode that enables fast and easy precision verification of your reference level. This function is a Dorrough exclusive (patent pending). In operation, whenever a reference tone is detected, the meter automatically switches to the expanded mode and the reference level is adjusted for a “null” on the meter display at -20dB (accurate to within 0.1dB).

The reference tone level in the digital audio domain is usually defined as 20 dB down from full scale, regardless of the number of bits in the audio word. The meter automatically detects the presence of 16 through 24 bit audio words.

Note: *Because different reference points are used in some countries, the -18 or -14 indicator becomes the target LED, depending on meter model.*

The Dorrough Window is enabled through either the DIP switch on the meter’s rear panel (position 2 is ON), or if the REF Mode button is pressed on the optional RW-100 remote control.

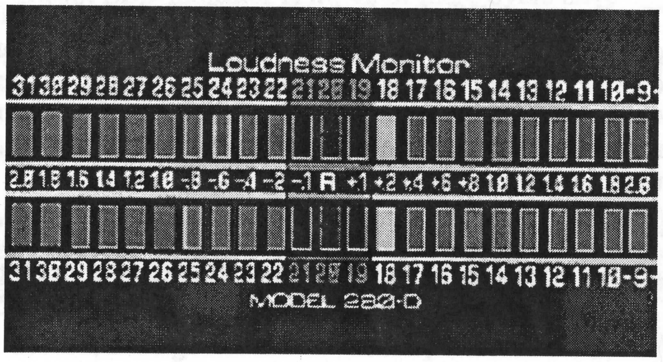
Once enabled, the meter displays normal dynamic program audio levels until the meter software detects the presence of a reference tone. When this happens, the meter activates the Dorrough Window feature. The -20 dB LED begins to flash at a 1 Hz rate to indicate that this mode is active and serves as a “target” indicating the absolute -20 dB reference point.

Above and below (adjacent to) the reference LED are two more LED indicators. If these indicators are not lit, the input tone to the meter is within +/- 0.1 dB of the -20 dB down point. If either of these two indicators lite, the input tone is more than +/- 0.1 dB from reference but less than +/- 0.2 dB. If the upper LED is lit, the input tone is too high. Conversely, if the lower LED is lit, the input tone is too low. Therefore, the two LED indicators above and below the flashing reference indicator have a resolution of +/- 0.1 dB.

In addition to the three 0.1dB reference LEDs, there are two banks of ten LEDs per bank. These indicators function just like the 0.1dB indicators discussed above except their resolution is 0.2 dB per step.

The further away from absolute reference level (-20 dB down) the input tone becomes, more of these LED indicators are lit. The LEDs light as a bar display to make them more visible from a distance. If the input tone level is greater than reference level, a solid LED bar will form above the flashing reference LED. If the input tone amplitude is more than 2 dB above reference level, all ten LEDs will be lit. If less than 2 dB above reference level, the LED indicators show how much above reference in 0.2 dB steps.

Conversely, if an LED bar forms below the flashing LED, this shows how far below the input tone is referenced to -20 dB.



* = Blinking at 1Hz rate

Figure 13, Dorrough Window Expanded Mode Detail

In the illustration above, the tone input signal is 0.3dB too hot. The reference level needs to be reduced to reach a "null" (only the blinking LED remains).

When the input tone is removed, the meter reverts to displaying normal program material. This expanded reference display mode is a powerful tool allowing operators to set levels in a precise, fast, and nonintrusive way.

Also available are meter versions with -18 and -14 references.

Phase Display

Background

Phase (or phase *correlation*) is a crucial aspect of producing good stereo but often overlooked or misunderstood. Phase in the context of stereo program material is a measure of the relationship of the two channels with respect to frequency and time. For example, a simple sine wave delayed by 180-degrees, will be completely "out-of-phase" with the original signal.

Combining these two signals results in their complete cancellation since at every point along the waveform, where one is positive, the other is equally negative producing no signal at all.

Delaying the original signal by 90-degrees and then combining it with the original, the new signal will have both a different amplitude and phase constructively and destructively with respect to each other.

In a much more complex manner, this is what happens when considering the two signals of a stereo program: the left and right signals maintain a certain phase relationship with each other. If kept discrete, there is no problem between the two. If there is sufficient phase difference between the two channels, severe cancellations can result in "comb filter" distortion of the signal and/or other transmission problems.

Looking at Phase

The original device for monitoring phase between the channels of a stereo program is an oscilloscope set to the "XY" display mode.

If the left channel is displayed on the vertical axis and the right channel on the horizontal, when the two signals are identical (i. e. mono) and in-phase, an upward-sloping diagonal line appears on the 'scope display: if the signals are 180-degrees out-of-phase (such as would occur if a cable were wired incorrectly), the display would show a downward-sloping diagonal line. A 90-degree out-of-phase condition described above would result in a circular display.

Phase in Stereo, Broadcast, and Surround Sound Production

Broadcast and film production rely on maintaining proper phase relationships between the channels so that their respective transmission systems will work as intended. The sum-and-difference nature of radio and television broadcast signals and the phase-dependent matrix encoding schemes of film surround sound systems demand that these phase relationships be carefully controlled. Good, coherent phase relationships between the channels result in proper stereo (or surround) imaging for the listener. Taken to the extreme, however, out-of-phase signals can cause serious cancellations for broadcast signals, even to the extent that for monophonic listeners, the signal can disappear entirely. For surround sound listeners, out-of-phase signals will be directed into the surround speakers.

The Dorrough Phase Display

The Dorrough Loudness Meter provides a Stereo Phase mode to monitor the stereo phase of the program signals. Like the oscilloscope display, it provides an easy to read indication of the phase relationship of the stereo signals.

The meter can display true mathematical phase correlation between the left/right audio signal pair. Phase is detected based on audio polarity only and is independent of the signal amplitude. Phase display is activated by pressing the Phase button on the RW-100 remote control. When enabled, a single LED is lit in both display rows to indicate relative phase.

If the two signals are identical (mono) and in-phase, the topmost LED on the Dorrough meter is illuminated as in Figure 14A. Similarly, if they are mono but out-of-phase, the bottom most LED is lit (Figure 14D). If there is no signal, or if the stereo signals are randomly correlated, the center LEDs are lit (Figure 14C).

Good phase-coherent stereo program material is displayed somewhere within the upper half of the Dorrough Phase display (Figure 14B). Poor phase integrity appears in the lower half (Figure 14E).

If the topmost (or right) LED is lit, then the channels contain identical frequencies and phase information. If the bottommost (or left) LED is lit, the two signals are identical frequency but 180 degrees out of phase. If the lit LED is somewhere in the middle, the two signals are random or uncorrelated. Nominal stereo signals will usually place the lit indicator in the upper half (or right) of the display.

If input signal levels fall below 30 dB down from full scale, the phase indicator will slew to the center position to indicate that the level is below the threshold necessary to produce a reliable reading.

Alarms

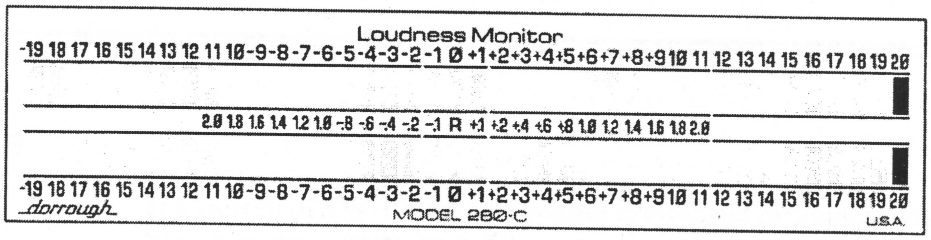
These meters feature an alarm closure which can be used to detect input signal parameter violations. The alarm closure is available on the meter's 8-pin mini DIN connector on pin 6.

The closure device is an open drain FET with a maximum rating of 30 VDC, 0.5 A. An LED, beeper, or external computer input can be connected to signal violations. The closure time is a minimum of one second to allow external equipment to respond to the alarm.

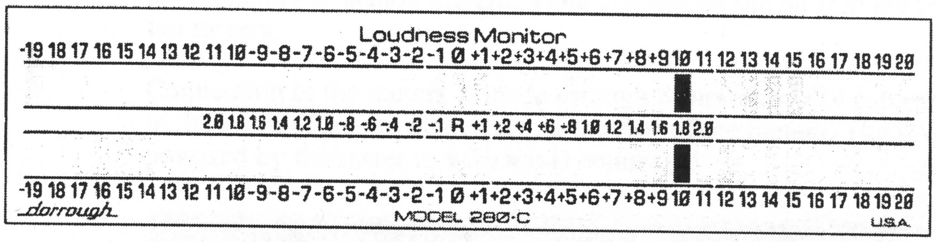
Alarm indicators for up to four meters can be monitored on the RW-100 remote control unit. The alarm closure feature is also duplicated on the RW-100.

The following conditions will activate the alarm in conjunction with DIP switch position 4:

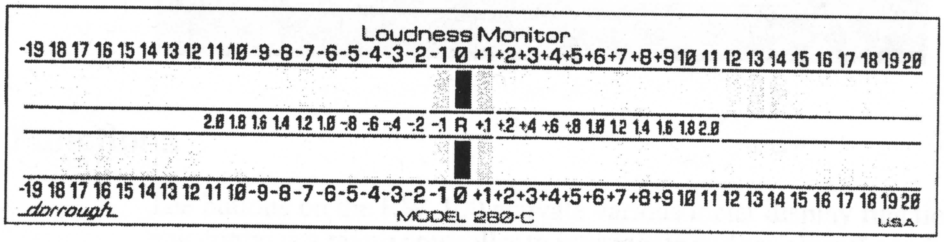
1. If a stereo phase error occurs (DIP switch position 4 is ON)
2. One or more overs are encountered (DIP switch position 4 is OFF).
3. The audio levels are insufficient to cause a display for a two minute period (DIP switch position 4 is OFF).
4. The alarm will close if the AES/EBU bitstream is corrupted (digital meters only), errored or missing entirely (DIP switch position 4 is ON or OFF).


Loudness Monitor
-19 18 17 16 15 14 13 12 11 10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 10 11 12 13 14 15 16 17 18 19 20
2.0 1.8 1.6 1.4 1.2 1.0 -.8 -.6 -.4 -.2 -.1 R +.1 +.2 +.4 +.6 +.8 1.0 1.2 1.4 1.6 1.8 2.0
-19 18 17 16 15 14 13 12 11 10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 10 11 12 13 14 15 16 17 18 19 20
dorrough
MODEL 280-C
U.S.A.

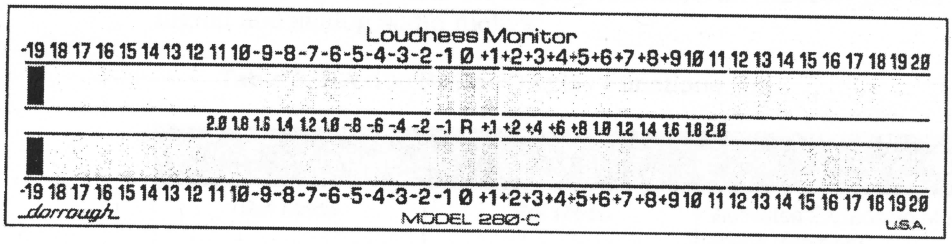
A. Mono, in phase


Loudness Monitor
-19 18 17 16 15 14 13 12 11 10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 10 11 12 13 14 15 16 17 18 19 20
2.0 1.8 1.6 1.4 1.2 1.0 -.8 -.6 -.4 -.2 -.1 R +.1 +.2 +.4 +.6 +.8 1.0 1.2 1.4 1.6 1.8 2.0
-19 18 17 16 15 14 13 12 11 10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 10 11 12 13 14 15 16 17 18 19 20
dorrough
MODEL 280-C
U.S.A.

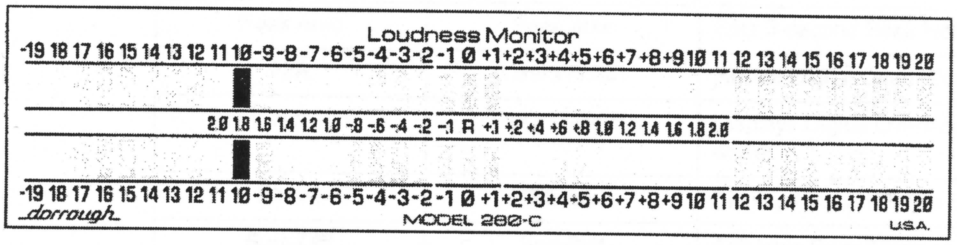
B. Normal stereo program material


Loudness Monitor
-19 18 17 16 15 14 13 12 11 10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 10 11 12 13 14 15 16 17 18 19 20
2.0 1.8 1.6 1.4 1.2 1.0 -.8 -.6 -.4 -.2 -.1 R +.1 +.2 +.4 +.6 +.8 1.0 1.2 1.4 1.6 1.8 2.0
-19 18 17 16 15 14 13 12 11 10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 10 11 12 13 14 15 16 17 18 19 20
dorrough
MODEL 280-C
U.S.A.

C. Random uncorrelated program material


Loudness Monitor
-19 18 17 16 15 14 13 12 11 10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 10 11 12 13 14 15 16 17 18 19 20
2.0 1.8 1.6 1.4 1.2 1.0 -.8 -.6 -.4 -.2 -.1 R +.1 +.2 +.4 +.6 +.8 1.0 1.2 1.4 1.6 1.8 2.0
-19 18 17 16 15 14 13 12 11 10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 10 11 12 13 14 15 16 17 18 19 20
dorrough
MODEL 280-C
U.S.A.

D. Mono, 180-degrees out of phase


Loudness Monitor
-19 18 17 16 15 14 13 12 11 10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 10 11 12 13 14 15 16 17 18 19 20
2.0 1.8 1.6 1.4 1.2 1.0 -.8 -.6 -.4 -.2 -.1 R +.1 +.2 +.4 +.6 +.8 1.0 1.2 1.4 1.6 1.8 2.0
-19 18 17 16 15 14 13 12 11 10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 10 11 12 13 14 15 16 17 18 19 20
dorrough
MODEL 280-C
U.S.A.

E. Normal stereo program material with reversed phase

Figure 14, Phase Display on the Dorrough Meter

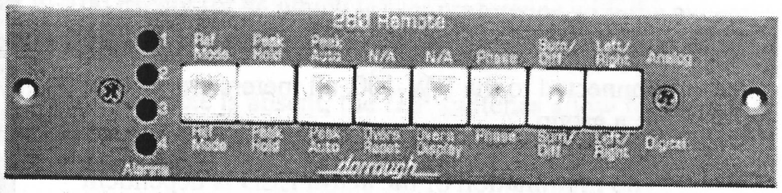
RW-100 Remote Control

4

Overview

The Dorrough RW-100 remote control is designed to connect with up to four Dorrough meters, providing convenient access to all meter functions. The RW-100 supports both the digital and analog meters. Button legends on the top apply to analog meters, while legends on the bottom are for the digital meters.

Connection to the meters is made through 8-pin mini DIN cables attached to the Alarm/Remote connector on the rear of the meters. The RW-100 is powered by the meter to which it is connected.


1
2
3
4
Alarms
Ref Mode
Peak Hold
Peak Auto
N/A
N/A
Phase
Sum/Diff
Left/Right
Analog
Ref Mode
Peak Hold
Peak Auto
Overs Reset
Overs Display
Phase
Sum/Diff
Left/Right
Digital
dorrough

Display Functions

The buttons on the RW-100 activate various meter display functions. The unit contains a micro controller to interrogate and serialize the switch status.

The following table lists the display functions on the RW-100 for both the digital and analog audio meters:

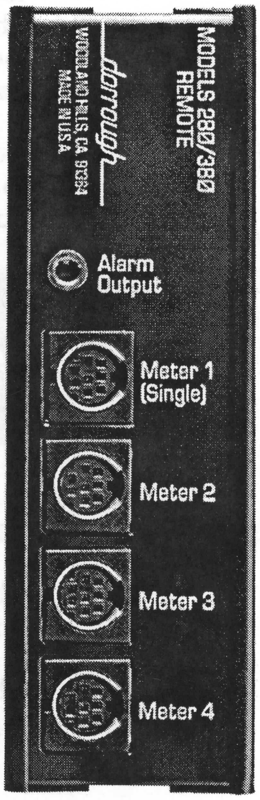
Table 3, RW-100 Button Display Functions

Analog Meter	Digital Meter	Display Function (when On)
Ref Mode	Ref Mode	Activates Expansion Mode (Dorrough Window)
Peak Hold	Peak Hold	Activates Indefinite Peak Hold
Peak Auto	Peak Auto	Sets 3-second Peak Hold
N/A	Overs Reset	Resets Digital Overs Counter
N/A	Overs Display	Displays Digital Overs on meter scale
Phase	Phase	Displays Stereo Phase Error
Sum/Diff	Sum/Diff	Activates Sum/Difference Display
Left/Right	Left/Right	Activates Left/Right Display

If the RW-100 duplicates any DIP switch display function on the meter, the function is then OR'd. Example: if the Peak Auto DIP switch position is on, OR if the RW-100 Peak Hold button is on, 3-second Auto Peak display is active (ON).

Note: *It is recommended that all DIP switches be placed in the OFF position (with the exception of the termination and range switches) when accessing display functions from the RW-100.*

When more than one meter is connected to the RW-100, all meters are controlled as a group when operating the remote.



Alarm Outputs

Alarm status LEDs are located on the left side of the Remote Control and are numbered one through four indicating the number of meters that can be connected to a single remote. If more than one meter is connected to the RW-100, all meters are controlled as a group.

The illumination of the alarm LED is dependent upon DIP switch #4 and will indicate any one of the following errors for the meter(s) corresponding to that position:

1. Stereo phase error.
2. The audio levels are insufficient to cause a display for a defined period.
3. The audio level is full scale or greater.

Alarm/Remote Contact Connection

A custom alarm output port is provided at the rear of the remote as a miniphone jack. The limitations of this circuit are those of the meter alarm closure device, an open drain FET with a maximum rating of 30 VDC, 0.5 A.

An LED, beeper, or external computer input can be connected to signal violations. The closure time is a minimum of one second to allow external equipment to respond to the alarm.

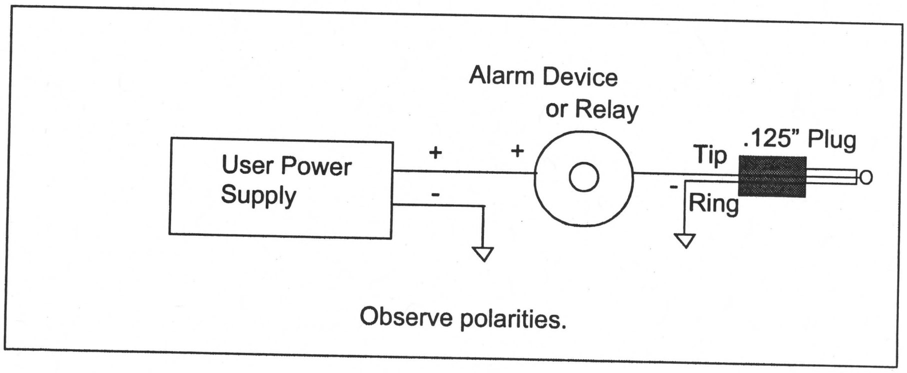

Alarm Device
or Relay
User Power
Supply
+
-
+
Tip
.125" Plug
-
Ring
Observe polarities.

Figure 15, RW-100 Alarm Connection

It is recommended that all DIP switches be turned OFF when operating an RW-100 except for #4 which is user preference with the exception of the termination and range switches.

When the remote is absent, the DIP switches allow for access to the same functions except for phase display.